(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 403 187 A1**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: 90306292.5

(22) Date of filing: 08.06.90

(51) Int. Cl.5: B32B 5/18, D04H 13/00, A61F 13/15

(30) Priority: 12.06.89 DE 3919166

(43) Date of publication of application: 19.12.90 Bulletin 90/51

(84) Designated Contracting States: AT BE CH DE DK ES FR GB GR IT LI LU NL SE

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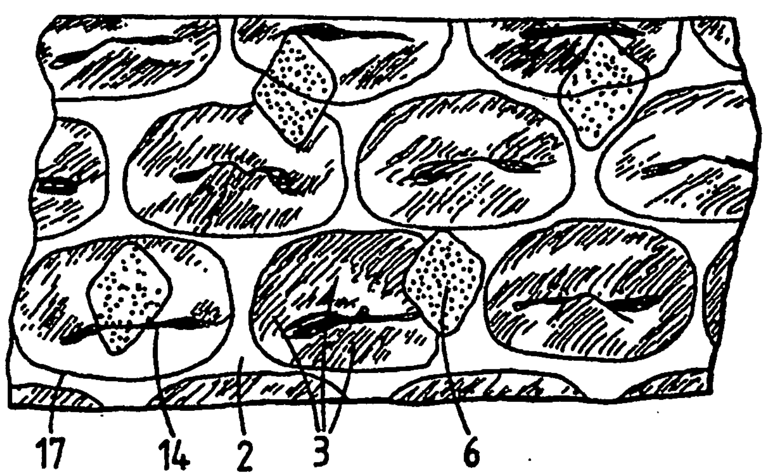
(54) **Flexible composite with a perforated plastics film bonded to a fibrous layer and method of making the same.**

(57) A method for producing a flexible composite by bonding a perforated plastics film to a fibrous layer, using prssure and heat, characterised by the fact that the film has perforations within embossments on the film, these embossments being compressed (preferably during bonding of the film and fibrous layers), whereby the width of the perforations is reproducibly reduced. The film is preferably stretched in one direction to narrow the perforations into the shape of a slit. The film and the fibrous layer are spot welded together, whereby the fibrous layer is reinforced by bonding.

FIG. 4



EP 0 403 187 A1

The firm bonding of a perforated film to a fibre layer produces a surface material that has good properties as regards thermal insulation and the exclusion of liquid and dust. It may be used for clothing, especially protective clothing, or dressings and suchlike. The perforations should permit the interchange of air and moisture without allowing liquid to enter. Producing perforations that, on the one hand, are sufficiently narrow and, on the other, are sufficiently numerous to permit a satisfactory interchange of gas, is difficult. Such tiny perforations cannot be produced by mechanical means. Intentional tear formation in the film, produced by embossing pressure (DE-A 37 24 510) does not give a reproducible, constant perforation size. A proposal was therefore made (DE-A 15 04 709) to subsequently reduce the perforations produced in a film, to the desired extent, by closing them up. This is expensive and difficult, and results in an undesirably excessive consumption of film material. The effect is also very limited, a maximum of about 10% change in the permeability being achieved, which is not sufficient for reducing mechanically produced perforations to the required extent.

It is an object of the present invention to provide a method for producing a flexible composite by firmly bonding a perforated plastics film to a fibrous layer, by exerting pressure and preferably also heat, which reproducibly reduces the size of the perforations.

The solution according to the invention consists of using a film whose perforations lie in embossments on the main surface of the film, and pressing them together.

In pressing the embossments together, the edges of the perforations are also greatly deformed so that the size of the perforations are reduced. By irregular crushing of the embossments, it is possible to obtain a minimum reduction in size for each perforation within statistically reproducible limits.

The compression process is preferably carried out at right angles to the plane of the film, and in the course of bonding the film to the fibrous layer. This is done simply by bonding the film to the fibrous layer under pressure and heat since, in such a method the embossments are anyway compressed at right angles to the plane of the film. If the bonding takes place under the action of heat, i.e. preferably in a welding process, the embossments are simultaneously fixed in the compressed state due to thermoplastic deformation. Moreover, it is of advantage to arrange the embossments on one side of the film facing the fibrous layer so that they are also held in place, in the compressed state, by the fibrous layer.

The type of the fibre bonding in the fibrous layer is not critical to the invention but a non-woven fibrous layer is preferably used because (a) it can be easily made, (b) it has a more uniform structure than woven or knitted materials, and (c) in view of its ability to prevent ingress of water and dust, may be beneficial as regards the sealing property.

Thus the non-woven fibrous layer preferably consists of a material that can be welded to the film. The non-woven fibrous layer may consist of staple fibres, fibrous mixtures or spun-bonded fibres. They are of such a composition that fixing by thermal means is possible. The fibrous material can also be treated with antistatic, hydrophilic or hydrophobic, or flame retardant additives. Both film and fibrous layers may contain starch which enables biological degradation of the composite.

To produce a satisfactory bonding of the film and fibrous layers, their melting ranges should be very close. It has been shown that a co-extruded fibre consisting of a polypropylene core and an outer layer of polyethylene, in combination with a polyethylene film can be used very successfully. To enable purely non-woven fibrous layers of pure polypropylene to be used it is important that the melting point of the film is close to that of the polypropylene. It was found that mixtures of polypropylene and polyethylene - particularly low-density polyethylene - or mixtures of polypropylene and ethylene/vinyl acetate copolymer are most suitable.

The type of bonding used between the film and the fibrous layer is not limiting as regards the scope of the invention. An adhesive bonding process even may be employed. A spot-weld type of bonding is preferred since this can be done at the same time that the internal reinforcement of the fibrous layer is carried out so that the fibres in the vicinity of these spot welding points are welded not only to the film but to each other. In so doing, the pattern of weld points in relation to the pattern of the perforations in the film should be such that these perforations are not closed to any great extent by the weld points. The pattern and dimensions of the weld points should not be allowed to conincide with those of the film perforations and should be mutually positioned so that the perforations in the film are not affected by the weld points. This can be achieved in practice, if the distance between the centres of the weld points, at least in one direction, differs from the distance between centres of the embossments and a simple multiple and a simple fraction of it, such that the weld points and film perforations overlap only by chance and in very limited areas, this overlapping being statistically uniform. Preferably, the distance between the bonding points in at least one direction is not more that twice the centre-to-centre distance of the embossment. It is also advisable for the bonding area of the weld points to be between 5 and 30% of the total area of the composite. The su-

perficial extent of the weld points should be less than the largest dimension of the perforations so that complete closure of the perforations is improbable even if a weld point coincides with a perforation.

To produce a weld joint between the film and the fibrous layer, the film and fibre material(s) of the fibrous layer should have substantially the same or at least similar melting ranges.

According to one beneficial feature of the invention, the narrowing of the size of the perforations not only occurs due to irregular crushing of the embossments, as is likely to occur with compression in a direction at right angles to the film surface, but the perforations which previously have approximately the same cross-sectional dimensions (for example are bounded by a circle or a polygon) are stretched in one direction to form a slit. According to the invention, this is achieved by stretching the film in a longitudinal direction, whereby the perforations tend to narrow in the form of a slit, i.e. more so than that due to stretching alone, and additionally, if the compression takes place subsequently or sumultaneously at right angles to the film surface. The perforation boundaries that are opposite each other at right angles to the stretching direction fold together, as it were, over one another so that the perforation itself is then deformed into a narrow slit if, say, it was previously circular in shape. The extent of the stretching required can be easily determined by testing. In general, slight stretching which occurs anyway due to the longitudinal tension is sufficient if the film and the fibre layer are passed through a calender for bonding purposes.

To prevent perforations from being closed due to their edges over-lapping one another, provision can be made to ensure that the wall length of the embossments, measured between the base of the embossments in the compressed film surface and the edge of the perforation, is not significantly greater than half of the base diameter of the embossments. The wall lengths must usually be slightly larger because the compression often results in a shortening of the wall length due to irregular bending or crushing. However, other versions for producing especially narrow or splash proof perforations may be required if the edges of the perforations overlap with one another. In this case, films in which the wall length of the embossments is correspondingly greater are used.

The invention is further illustrated below by reference to the drawings accompanying the specification.

Fig. 1 - the cross section of a suitable film

Fig. 2 - the cross section of another version of a suitable film

Fig. 3 - the cross section of the finished surface material

Fig. 4 - an enlarged view from above of part of the film side of such a composite.

Figs. 1 and 2 show films that can be produced, for example, according to DE-A 29 21 078, DE-A 27 46 440, DE-C 25 56 501, EP-A 0 138 601, GB-A 2 014 508, EP-A 0 203 823, EP-A 0 141 654 or DE-A 37 23 404. Film 1 shows, projecting from the film surface 2, embossments whose walls 3, at least partly taper towards the corresponding perforation, are specifically reduced by deformation and at their uppermost point contain a perforation 4 which preferably is of uniform cross-section. The embossments and the perforations may however be stretched longitudinally or be oval shaped whereby, specifically, their longitudinal direction coincides with the elongation direction in the subsequent compression of the embossments. The dimensions of the perforations (the transverse dimensions in the case of the longitudinally stretched perforations) in the initial state are specifically of the order of one to a few tenths of a millimetre. The heights of the embossments above the uncompressed film surface 2 is between 0.2 and 3 times the perforation diameter, ideally 0.5 to 2 times. The wall length of the embossments, between the base 7 and the edge of the perforation 8, is preferably not significantly more than the base diameter. The mid-point distance between the embossments is preferably one to three times the diameter of the base.

The film may be of uniform thermoplastic materials, mainly polyolefins, or blends of plastics, depending on the proposed application. The properties required, such as antistatic, feel, surface tension (water propellant), antibacterial or flame resistant properties can be produced by means of additives. Delustering material such as chalk, microtalcum, aluminium hydroxide or silicic acid, for example, may be added. The open area of the perforated film in its initial state constitutes suitably between 4 and 40%, preferably between 10 and 20% of the total area.

To reinforce the non-woven fibrous layer and to bond the film and fibrous layers, they are passed through a heated embossing calender as illustrated and explained, for example, in DE-A 37 24 510. The heated rolls of the embossing calender are so designed that spot welding occurs in the area of the points 6 (Fig. 4) which are uniformly distributed and whose individual area is in proportion to the size of the embossments 3 and the openings 4. The embossments 3 are compressed between the calender rolls at right angles to the film surface, whereby the opposite parts of their walls and edges come close together as shown in Fig. 3. This proximity of the opposite edges of the holes is required so that tension is exerted on the film at

right angles to the film surface. By this means, the slit shape of the perforation 14 shown in Fig. 4 is obtained. This Figure 4 shows a 40 X electron micrograph of a sample in which the perforations 14 are shown black, and the shadows produced in the area of the irregularly compressed embossments are shown shaded. The base lines of the embossments are illustrated by lines 17. The undeformed area of the film between the embossments appears white. Weld points are shown as dots. It is seen that a relatively uniform, reproducible reduction in the size of the perforation to an average width can be achieved which is of the order of one tenth of the initial diameter, deviations at the top being comparatively rare. Depending on the size of the initial perforations 4, the width of the opening slit 14 is a few hundredths to about one tenth of a millimetre. This is sufficient, for example in combination with convention water repelling agents, to ensure prevention of water and dust passing therethrough, therefore rendering it suitable for clothing purposes.

During the processing of the film, involving stretching, no specific tension forces, or only slight tension forces, are exerted at right angles to the stretching direction, so that its dimension is retained in this transverse direction. Even under the effect of stretching, the size of the perforation can contract in the other direction. In some cases, it may even be of benefit to allow a slight formation of small corrugations in the stretching direction.

As can be seen from Fig. 4, the pattern of weld points 8 differs from that of the embossments 3 such that as a rule no adjacent perforation in the film is completely closed. The composite produced according to the invention may consist entirely of film and fibrous layers. Firm or loose bonding with other layers by this means however is not excluded.

Example 1

A perforated film of approx. 32 g/m^2, consisting of linear low density polyethylene, with a density of 0.912 and a melt flow index of 3.3 was applied to a staple non-woven fibrous layer, having fibre fineness of 1.7 dtex (40 g/m^2) and consisting of a two-component fibres, low density polyethylene/polypropylene, (LDPE/PP) before feeding into the thermal bonding calender. The perforated film had about 120 perforations/cm^2. The diameter of the perforations was approx. 0.32 mm. This corresponds to a free area of about 10% of the total area of the composite. The perforations were venturi-shaped embossments, whereby their free ends could face either towards the non-woven fibrous layer or away from it. The proportion of the bonding area produced by compressing in a steel roll was about 20% of the total area of the composite. The perforations were compacted in the weld area so that a total open area of about 6% was produced. The non-woven fibrous layer and the film were antistatically treated; the non-woven fibrous layer was also treated with a water repellant. Complete watertightness was achieved, particularly with respect to prevention of splashing. Due to the thorough bonding of the fibrous layer to the film, and the fineness of the perforations, the composite was virtually free from loose fibres, and was impermeable to dust; the composite could be used for protective coating in clean areas.

Example 2

As in Example 1, a perforated film (32 g/m^2) was applied (before bonding the non-woven fibrous layer) to a spun-bonded non-woven fibrous layer (40 g/m^2) with a fibre fineness of 1.7 dtex, and consisting of pure polypropylene (PP). The film, consisted of parts of a PP, density 0.898, melt flow index 8, and 60 parts of a linear low density polyethylene (LLDPE) of density 0.912, melt flow index 3.3. The non-woven fibrous layer and film had received prior antistatic and water repellant treatment. The film material had a melting point of about 150 °C. This melting point was sufficiently close to that of the PP to be within a common melting range on sealing the film with the non-woven fibrous layer to avoid burning through the film. Due to the high proportion of LLDPE of low density, the required softness and elasticity of the whole composite was achieved. In order to obtain a dry feel and a matt surface, about 10% of chalk (particle size from about 1 to 3 micron) in concentrate form was added to the film material.

Example 3

A perforated film, which was also treated with a flame retardant, was welded to a non-woven fibrous layer (corresponding to Example 1) as described in Examples 1 and 2, during the bonding of the non-woven fibrous layer. The flame retardant property of the film was achieved by adding commercial concentrates, ie 15% of the concentrate B 10318 (made by Constab) was added to the LLDPE type (density: 0.912, MFI: 3.3). The non-woven fibrous layer consisted of staple fibres (40 g/m^2). The film had a weight of approx. (32 g/m^2). The bond complied with the flame retardant standard according to DIN 53438 both as regards edge flaming (K1) and surface flaming (F1) of the front and back.

Claims

1. A method of producing a flexible composite by firmly bonding a perforated plastics film to a fibrous layer, by the action of pressure, and preferably, also heat, characterised by the fact that a film is used whose perforations are in embossments on the film surface, and that these embossments are compressed.

2. A method according to claim 1, characterised by the fact that the compression is carried out during the course of bonding the film to the fibrous layer.

3. A method according to claim 1 or 2, characterised by the fact that the compression is at right angles to the film surface.

4. A method according to any one of the preceding claims 1 to 3, characterised by the fact that the embossments, which are at least partially conical in shape, narrow towards the corresponding perforations.

5. A method according to any one of the preceding claims 1 to 4, characterised by the fact that the film and the fibrous layer are spot welded together.

6. A method according to claim 5, characterised by the fact that the spot welding is carried out with simultaneous bonding of fibrous layer which reinforces said layer.

7. A method according to any one of the preceding claims 1 to 6, characterised by the fact that the embossments are on the side of the films facing the fibrous layer.

8. A method according to any one of the preceding claims 1 to 7, characterised by the fact that whilst compressing the embossments, the film is stretched in one direction.

9. A composite comprising a perforated film and a fibrous layer firmly bonded to each other, characterised by the fact that the perforations (4) on the film (1) are within the compressed embossments (3) on the film (1).

10. A composite according to claim 9, characterised by the fact that the embossments (3) are compressed at right angles to the film surface.

11. A composite according to claim 9 or 10, characterised by the fact that the perforations (4) are narrowed, to form longitudinal slits along the length of the film.

12. A composite according to any one of the preceding claims 9 to 11, characterised by the fact that the film (1) and the fibrous layer (5) are spot welded.

13. A composite according to claim 12, characterised by the fact that the fibrous layer formed from a non-woven fibrous layer is bonded to itself by the weld points (6).

14. A composite according to claim 12 or 13, characterised by the fact that the melting points of the materials of the fibrous layer (5) and the film (1) are substantially the same or are close together

15. A composite according to any of the preceding claims 12 to 14, characterised by the fact that the bonding area of the weld points (6) occupy between 5 to 30% of the total surface area of the composite.

16. A composite according to any one of the preceding claims 9 to 15, characterised by the fact that the distance between the weld points (6) in at least one direction is not greater than double the mid-point distance between the embossments.

17. A composite according to any one of the preceding claims 9 to 16, characterised by the fact that the mid-point distance between the weld points (6), at least in one direction, differs from the mid-point distance between the embossments (3) and a simple multiple and a simple fraction of it.

FIG.1

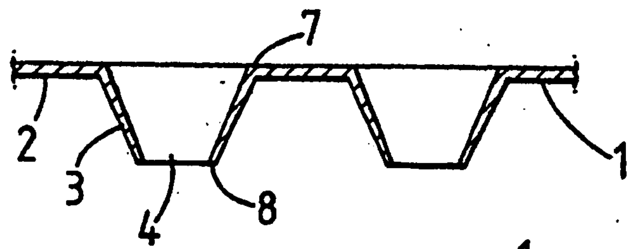


FIG.2

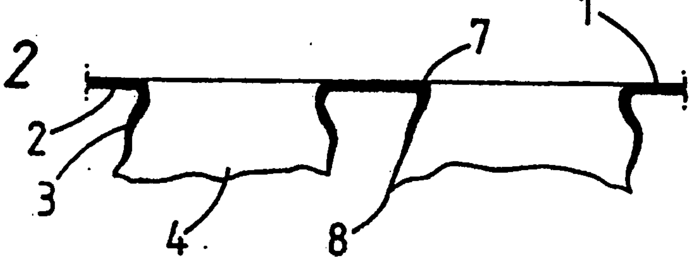


FIG.3

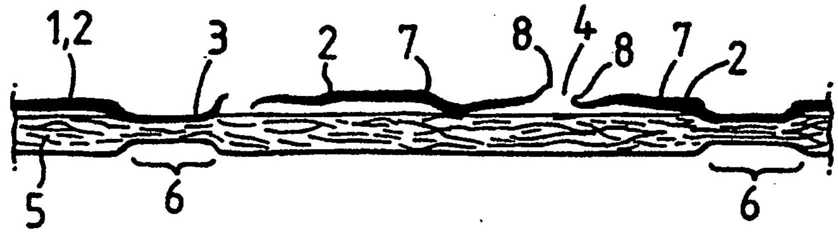
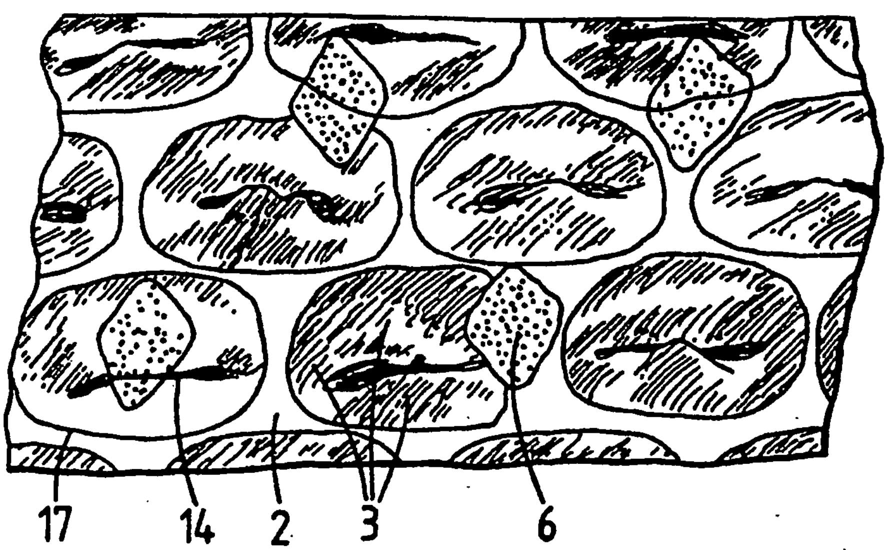


FIG.4



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Numero de la demande

EP 90 30 6292

DOCUMENTS CONSIDERES COMME PERTINENTS

Catégorie	Citation du document avec indication, en cas de besoin, des parties pertinentes	Revendication concernée	CLASSEMENT DE LA DEMANDE (Int. Cl.5)
D,X	GB-A-2 014 508 (UNILEVER) * Page 2, lignes 4-29 *	1-17	B 32 B 5/18 D 04 H 13/00 A 61 F 13/15
A	FR-A-2 227 126 (YHTYNEET PAPERITEHTAAT OY) * Page 1, lignes 10-17; page 1, ligne 36 - page 2, ligne 13 *	1-17	
D,A	DE-A-1 504 799 (RADUNER) * Page 4, last paragraphe *	1,9	
A	US-A-3 459 618 (EGLER) * Colonne 2, ligne 54 - colonne 3, ligne 16 *	1,9	

DOMAINES TECHNIQUES RECHERCHES (Int. Cl.5)

B 32 B
D 04 H
A 61 F

Le présent rapport a été établi pour toutes les revendications

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